

THE PREVALENCE OF POOR MATURATION OF ARTERIOVENOUS FISTULA IN
HEMODIALYSIS PATIENTS: A META-ANALYSISSharmarke Abdullahi Nor[#], Li Song[#], Wei Dong, Yuanhan Chen, Zi-lin Quan, Yan Yin, Zhiming Ye and
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ABSTRACT

Background: Poor arteriovenous fistula (AVF) maturation is a significant challenge that restricts the clinical utility of AVF in patients undergoing hemodialysis. **Objective:** To address the gap in knowledge regarding the current practices in the management of patients with CKD and AVF maturation. There exists a regional variation that can result in adverse outcomes and no comparative data to guide future clinical research. **Methods:** We performed a systematic search of the electronic databases of PubMed, Embase, MEDLINE, and Google Scholar till October 21, 2023, using the keywords “Maturation,” “Arteriovenous Fistula,” “AVF,” and “Dialysis.” We adopted this approach to optimize study retrieval, which included a summary of published English-language articles enrolling human subjects. **Results:** Our first search retrieved a total of 778 citations, of which 30 eligible studies were identified using deduplication, screening, and full-text review. These studies included a total of 7756 patients (95% CI: 24%-26%), and information on the globally pooled AVF poor maturation rate was 25% (95% CI: 24%-26%). Regional prevalence was 20% (95% CI: 16%–24%) in Asia; 28% (95% CI: 22%–34%) in Europe; and 27% (95% CI: 20%–34%) in the Americas. The pooled prevalence for males was 23% (95% CI: 19%-26%), whereas for females the pooled prevalence was 25% (95% CI: 21%-31%). **Conclusion:** The overall incidence rates of poor AVF maturation in hemodialysis patients vary by region, being higher in Europe and the Americas than in Asia, and do not depend on sex. It highlights the necessity of taking geographic regions into account for a clinical approach to AVF maturation and acts as a frame of reference for future studies.

KEYWORDS: Haemodialysis, poor arteriovenous fistula maturation, meta-analysis.

INTRODUCTION

Arteriovenous fistulas (AVFs) are the gold standard for vascular access in patients receiving hemodialysis due to their better long-term patency and lower rates of complications compared with other access forms, including central venous catheters and arteriovenous grafts.^[1, 2]

However, one of the most prevalent barriers to the overall success of AVFs is inadequate maturation, wherein the fistula fails to mature sufficiently to accommodate a dramatically increased blood flow rate needed for effective dialysis.^[3] The maturation of an arteriovenous fistula (AVF) is a complex and multifactorial biological process; factors that influence this process include the diameter of the blood vessels of the patient, the surgical technique used, and other comorbidities, such as diabetes and hypertension.^[4,5] Abnormal arteriovenous fistula (AVF) maturation is a major problem for patients and health care providers. When an arteriovenous fistula (AVF) is unable to

mature, the patient will experience a prolonged need for the catheter, which increases the risk of infection and greatly increases the cost of medical care due to reparative and replacement surgeries or procedures to preserve the patency of the malfunctioning fistula.^[6] The immature AVF is likely to delay or impede its use, which could impact patient outcomes directly given the levels of morbidity and mortality that patients with catheters are at in comparison to those with a functioning AVF.^[7] Although there are many research articles available discussing the causes of AVF maturation failure, differences in national health care systems, medical practice, and patient populations in the respective countries lead to differences in the incidence of inadequate maturation.^[8] A global understanding of this issue is necessary to enhance clinical practices and to improve outcomes in patients receiving hemodialysis. Despite the situation being significant for the continuity of care of patients on hemodialysis, knowledge gaps still exist in understanding the magnitude of the issue, and hence, this meta-analysis aims to address prevalence data

on arteriovenous fistula underdevelopment available in different parts of the world, which could help in determining clinical strategies and future research activities employed to combat what constitutes an important part of the hemodialysis treatment path.+

This analysis provides a comprehensive review of the proportion of hemodialysis patients who experience failure of AVF maturation, stratified according to region and gender. The research seeks to elucidate the significant hurdles presented by this condition, presenting potential advancements in therapeutic protocol and patient care and ultimately advocating optimized quality of care.

METHODS

Search strategy

A systematic search was conducted on the electronic databases PubMed, Embase, MEDLINE, and Google Scholar, from their inception up to 21st October 2023, to identify all relevant published articles. The strategy focused on three concepts: "Maturation", "Arteriovenous Fistula", "AVF", and "Dialysis". These terms were combined with keyword-search methods to accommodate papers with incorrect Mesh/Emtree coding and maximize study retrieval. There was no attempt to retrieve unpublished studies.

Inclusion and exclusion criteria

In order to meet the analysis requirements and reduce deviation, selected studies fulfilled the following criteria: (1) included studies concerning for arteriovenous fistula maturation failure in dialysis patients up to October 2023. (2) research methods: retrospective and prospective studies; (3) the definition of exposure factor is similar and no difference in diagnostic criteria of AVF failure; (4) included studies in full-text published English-language articles. Studies were excluded if we could not obtain information necessary for the completion of the prevalence of AVF Poor Maturation from the articles or the authors.

Quality of the studies

We accessed the quality of studies using the framework suggested by the Cochrane Collaboration for the inclusion decision. Quality assessment was carried out independently by three reviewers. If two of them or three agreed, the study can be included to the meta-analysis. The data from all included studies were clearly tabulated, and Outliers were taken into account and identified during the quality assessment stage.

Statistical Analysis

The systematic review summarized various studies in a table, including details like author, publication year, country, study design, sample size, and outcome analysis method. We only conducted a meta-analysis when studies were similar in terms of participants, interventions, outcomes, measurements, and data

aggregation methods. We used tables and figures to present the findings effectively. Meta-analysis was carried out using R programming language software version 4.3.1.

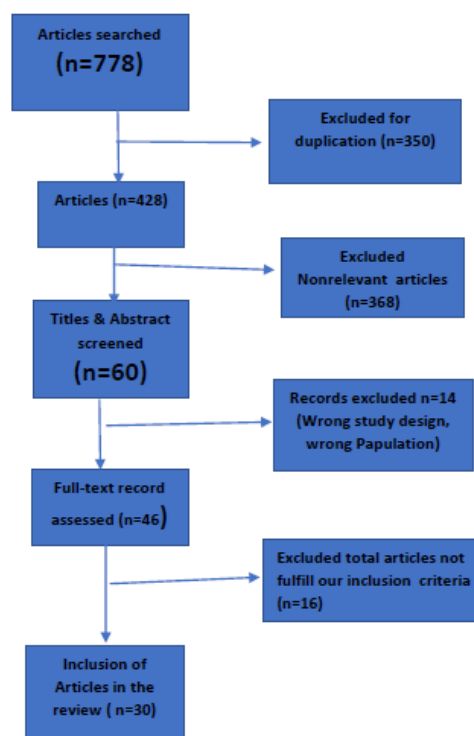


Figure 1: Flow of information through the different phases of a systematic review.

RESULTS

Our search on arteriovenous fistula maturation in dialysis patients began with 778 citations. After deduplication and restricting the search to studies involving human subjects published in English, 428 studies remained. After screening titles and abstracts, 60 studies seemed potentially eligible. Full-text review of these papers left 46 studies for consideration, with 30 meeting our eligibility criteria after a thorough reading. A population of 7756 was studied, revealing a prevalence of poor maturation of AVF was 25% (95%CI: 24%-26%). In Asia, the prevalence of poor maturation of AVF was 20% (95%CI: 16%-24%); In Europe, the prevalence of poor maturation of AVF was 28% (95%CI: 22%-34%); In American, the prevalence of poor maturation of AVF was 27% (95%CI: 20%-34%). The results showed that the pooled prevalence of poor maturation in male was 23% (95%CI: 19%-26%), but it was 25% (95%CI: 21%-31%) in female.

Table 1: Characteristics of the studies.

NO	First author & year published	Sample size	AVF_im mature	RATE	Female/ Male	age	Site	Country	Continent (America /Europe / Asia)	Study_Design
1	Sun, J (2023)	184	44	23.91	68/116	56.4 ± 14.1	RCF	China	Asia	retrospective
2	Suryawanshi (2023)	700	126	18.00	295/405	58.74	RCF/BCF/BBF	India	Asia	retrospective
3	Ghosh (2022)	205	55	26.83	56/149	40.7±13.08	RCF	India	Asia	prospective
4	Waheed A, (2020)	200	53	26.50	75/125	63.1	RCF/RBF	Canada	America	prospective
5	Feng, R, (2023)	121	16	13.22	46/75	53.88 ± 15.	RCF/RBF	China	Asia	retrospective
6	Abreu R (2022)	155	33	21.29	63/92	71	RCF/RBF	Portugal	Europe	prospective
7	Robbin ML (2018)	602	186	30.90	180/422	55.1±13.4	RBF	China	Asia	prospective
8	Misskey, (2020)	356	146	41.01	127/229	64.6	RCF/RBF	Canada	America	retrospective
9	Yap YS, (2021)	501	127	25.35	214/287	63.4±12.7	RCF/RBF	Taiwan	Asia	retrospective
10	Kaller (2023)	42	12	28.57	18/24	67.07 ± 10.2	RCF	Romania	Europe	prospective
11	Li, HL, (2020)	277	41	14.80	104/173	56.6 ± 16.9	RCF	China	Asia	retrospective
12	Kordzadeh, A, (2017)	324	110	33.95	80/244	65	RCF	UK	Europe	prospective
13	Srivastava A, (2018)	173	35	20.23	52/121	43.3 ± 11.5	RCF	India	Asia	prospective
14	Patel P, (2023)	104	36	34.60	17/87	51 ±13.5	RCF	India	Asia	prospective
15	Okamuro, L, (2019)	158	26	16.46	26/132	51.4	RCF	USA	America	retrospective
16	Farrington CA, (2020)	300	106	35.30	115/185	53±15	RCF/RBF	USA	America	retrospective
17	Hakim, AJ, (2022)	202	52	25.74	89/113	55.06	RCF/RBF	USA	America	retrospective
18	Hou, (2020)	97	21	21.65	44/53	54.11±14.19	RCF	China	Asia	retrospective
19	Gaur P, (2019)	422	38	9.00	102/320	69.3±2.5	RCF/BBF/BCF	India	Asia	retrospective
20	Yan, Q (2022)	380	205	53.95	247/133	57 ± 18	RCF/BCF	USA	America	retrospective
21	Shahverdyan (2023)	150	21	14.00	48/102	64	RCF	USA	America	retrospective
22	Kim (2021)	142	9	6.34	77/65	64.1±14.0	RCF/BCF	Korea	Asia	retrospective
23	Wang, B, (2021)	596	101	16.95	227/369	62.8 ± 13.7	RCF/BBF/BCF	USA	America	retrospective
24	Wang, Q, (2022)	365	101	27.67	130/235	56.34±13.76	RCF	China	Asia	prospective
25	Singh, M (2023)	129	42	32.56	29/100	40.95±13.98	RCF/BCF	India	Asia	prospective
26	Anderson, L, (2023)	202	50	24.75	89/113	54.6(1.6)	RCF/BBF/BCF	USA	America	retrospective
27	Gasparin, C, (2022)	145	32	22.10	57/88	59	RCF/BBF/BCF	Brasil	America	prospective
28	Minxia (2023)	197	34	17.26	54/109	57.9±16.5	RCF/BCF	China	Asia	retrospective
29	Gomes (2021)	132	34	25.76	51/84	71.0(15.0)	BCF/BBF	Portugal	europa	prospective
30	Wongmahisorn, (2020)	195	27	13.85	89/106	60.6 ± 13.9	RCF/BCF	Thailand	Asia	retrospective

In table 1 represent the main characteristics of the studies included in this systematic review are presented: First author, publication year, n (sample size), AVF maturation (AVF ready for cannulation), gender distribution (male: female), average age, study setting, country, continent, and study design. The study reports variable sample sizes (42 to 700 participants) and maturation rates (6.34% to 53.95%). Show both male-to-female ratios and age averages with respective standard deviations, indicating that both age and sex may influence AVF maturation outcomes.

Table 2: Prevalence of Poor Arteriovenous Fistula Maturation by Region.

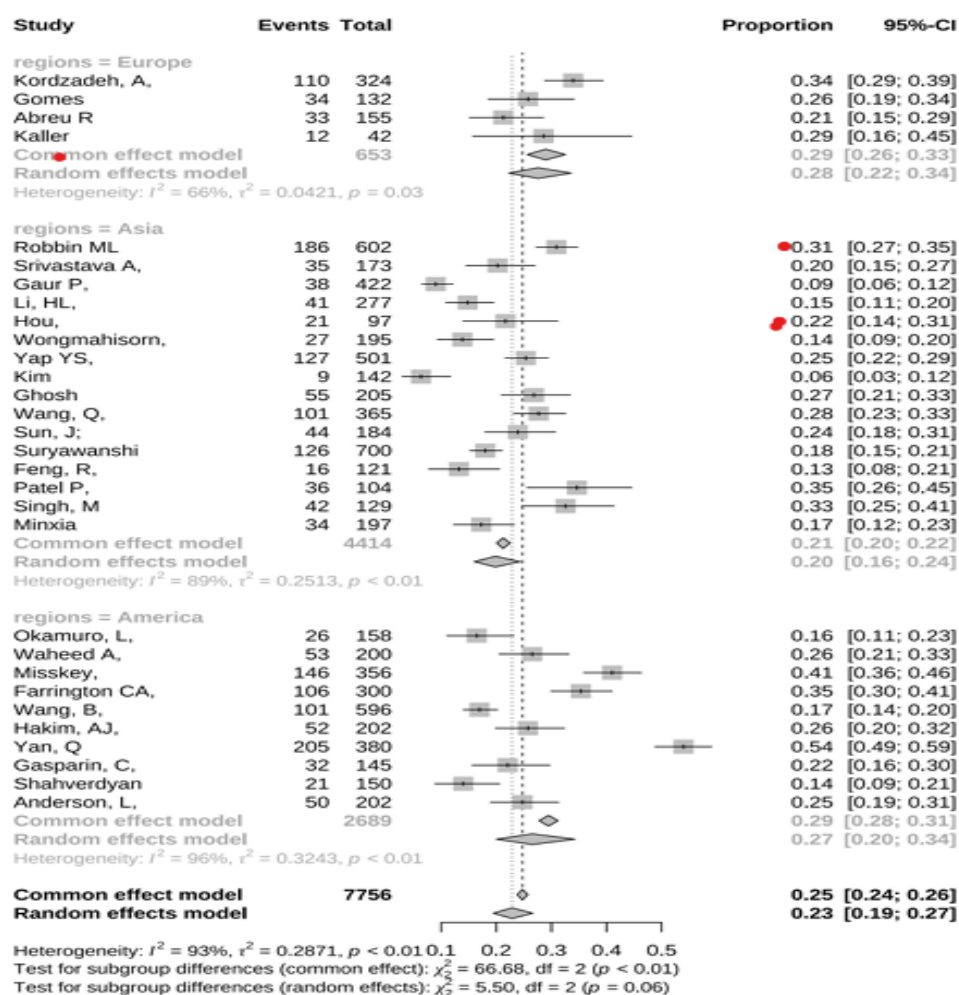


Table 2: Indicates geographical region variations of pooled poor arteriovenous fistula maturation prevalence. Results showed that the lowest prevalence of individuals having the disease was among the people in Asia at 20%, followed by America with 27%, and the highest being in

Europe with 28%. These variances from region to region reveal that some parameters, such as surgical methods, patients' characteristics, and healthcare availability, may contribute to AVF maturity overall outcomes.

Table 3: Risk Ratios for Poor Arteriovenous Fistula Maturation by Gender.

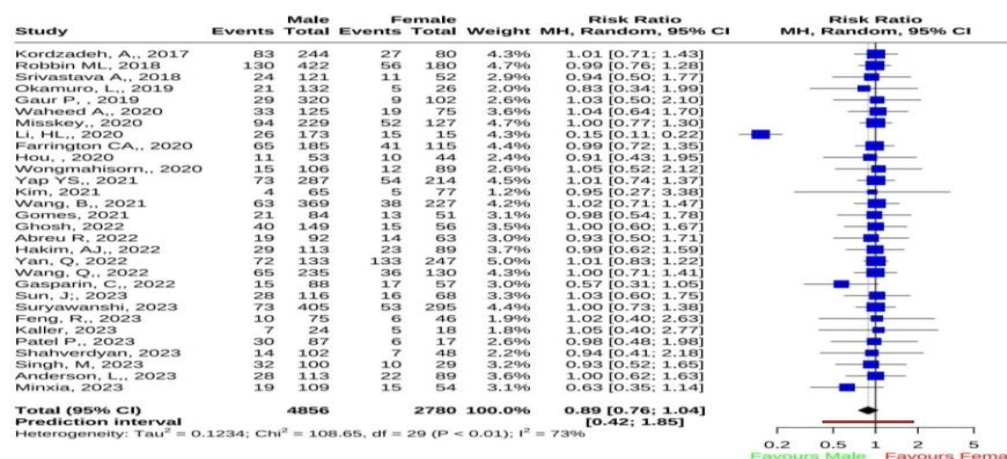


Table 3 shows the risk ratios of not having an appropriate AVF maturation between different genders.

23% prevalence in males and a greater incidence of females, 25%. This suggests that female sex may have an

increased risk for under-maturation, which may be due to anatomical or physiologic factors that merit further investigation.

DISCUSSION

This study reports that the overall occurrence of immature arteriovenous fistula (AVF) among hemodialysis patients is 25% (95% CI 24 to 26). The finding is based on a large meta-analysis including 30 eligible studies and a total population of 7,756 patients. This low maturation rate is an important obstacle in the clinical care of patients undergoing hemodialysis, thus highlighting the need for better approaches to improve arteriovenous fistula maturation.

Notably, our study shows region-specific incidence of immature arteriovenous fistula (AVF) among hemodialysis patients that are as follows: Asia: 20% (95% CI 16% to 24%) In Europe, this prevalence rose to 28% (95% CI: 22%–34%). The incidence is also equally high in the Americas (27%, 20%-34% CI). Differences in clinical practice patterns, patient demographics, and possibly genetic predisposition promoting poor AVF maturation may contribute to these regional disparities, this study suggests. This has important clinical implications as far as regional specificities should be taken into consideration for achieving the optimal AVF maturation in our hemodialysis patients. These regional differences align with those found in other studies, as studies have found an incidence of 26% in North American cohorts and attributed these differences in incidence to differences in healthcare systems, access to care, and differences in patient demographics.^[9]

Furthermore, other studies echoed these findings in regards to AVF outcomes, with the geographical and socio-economic aspects supporting our reasoning. They wrote that the higher incidence rates in developed regions may be related to improved preoperative assessments and more aggressive surgical techniques. These findings underscore the need to develop region-specific strategies to optimize AVF maturation in patients on hemodialysis.^[10]

The pooled prevalence of poor AVF maturation was 23% (95% Confidence Interval (CI): 19%–26%) in males and 25% (CI: 21%–31%) in females. The point is consistent with the idea that gender may not be an important factor influencing maturation of AVFs among hemodialysis patients, highlighting possible regional trends, practice differences, and health conditions of the patient cohorts as further factors that may be potential contributors to overall outcomes with AVFs. This is consistent with results from a previous study that showed similar rates for AVF maturation between males vs. females but pointed out that the major factors leading to AVF success or failure were related to comorbidities, including the presence of diabetes and hypertension.^[11]

The limitation of selection bias of this study has to be acknowledged, because only studies published in the English language have been included; the study may miss important studies published in other languages. This study tries to include distance in the regions; however, representation of that region has dependency on the availability of studies. Variation in Study Design: Studies varied in their design, sample size, and methodology, which may introduce heterogeneity in estimating the prevalence of these immature AVFs. In particular, heterogeneity has been recognized, and it has been observed that the differences in definition and diagnostic criteria of AVF immaturity may result in the discrepant prevalence across the studies.^[12]

In the future, possibly also the standardization of the definition of the immature AVF, and multicentric studies with heterogeneous study populations may be the best approach to clarify the factors associated with AVF maturation. In addition, studying the biological pathways that regulate AVF maturation in different populations could enable tailored therapeutic strategies, ultimately influencing hemodialysis morbidity in these populations.

CONCLUSION

The incidence of poor arteriovenous fistula maturation in patients undergoing hemodialysis exhibits regional variations, lower in Asia than in Europe and the Americas. The disparity in the incidence of insufficient arteriovenous fistula maturation between genders is insignificant.

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